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INTEGRATION OF KM AND MIS PROCESSES IN STRUCTURAL EQUATION MODELLLING (SEM) CORROBORATION OF EPC SUPPLY CHAIN MODEL

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ABSTRACT

Today's world is moving in turbulent economic environment, firms are striving for ways to achieve competitive advantage. The Supply Chain Management Program integrates topics from operations, purchasing, transportation, and physical distribution into a unified program. Successful supply chain management, then coordinates and integrates all of these activities into a seamless process. It embraces and links all of the partners in the chain. In addition to the departments within the organization, these partners include vendors, carriers, third party companies, and information systems providers. One of the approaches is to manage the entire supply chain through integration of Knowledge Management to improve performance so as to create competitive advantage and business success. Knowledge Management (KM) being a human centered approach enables the supply chain function to gain more comprehensive, integrative & reflex view in the industries.MIS systems which is closely related to the tacit Knowledge method can be used to collect, develop & validate the data which is obtained through successive KM application since MIS satisfies the diverse needs through a variety systems such as query systems, analysis systems & decision support systems. This research provides a theoretical framework to understand EPC Industry and argues that supply chain management will help these firms to be competitive and successful. In order to leverage on existing supply chain investments, firms in the EPC industry, like many other industries, are faced with the challenge of being able to align their supply chain strategies with the effective use of technology. With the support of Management Information System (MIS) Factor analysis is done using Statistical Package for the Social Sciences (SPSS) software to evaluate the relative importance of Important Supply Chain Factors in the EPC Sector. The data is analysed using "Mean score". Further the data is analysed through Structural Equation Modelling Confirmatory Factor Analysis (CFA) to find the fitness of the data.

KEYWORDS*:* EPC Industry, Knowledge Management, MIS Approach, Important SCM Factors, Support of Information Technology

I. INTRODUCTION

A. EPC an Overview

EPC (engineering, procurement and construction) deal with the production of complex industrial goods such as industrial plants, processing plants and large infrastructures The engineering and construction contractor will carry out the detailed engineering design of the project, procure all the equipment and materials necessary, and then construct to deliver a functioning facility or asset to their clients. The EPC phase of the project is also known as the Execution phase which normally follows what is known as a FEED or Front End Engineering Design phase. The FEED is a basic engineering design used as the basis for the EPC phase. The FEED can be divided into separate packages covering different portions of the project. The FEED packages are used as the basis for bidding on when the client offers the EPC work to the market, normally

the EPC Contractor has to execute and deliver the project within an agreed time and budget, commonly known as a Lump Sum Turn Key (LSTK) Contract. An EPC LSTK Contract places the risk for schedule and budget on the EPC Contractor. The Project Owner or client to the EPC Contractors will normally have a presence in the EPC Contractors offices during the execution of the EPC Contract. The Client places what can be termed a Project Management Team or PMT to overlook the EPC Contractor. The client PMT may require specialist help and bring on board Project Management Consultants or PMC's to assist. The PMT / PMC will ensure the EPC Contractor is carrying out the works in accordance with the agreed scope of works and in accordance with the Contract. It is quite common for the Engineering and Construction Contractor which delivered the FEED to be offered a Project Management Consultancy (PMC) Contract. In some instances which can be related to the time a project owner would like the project delivered, an engineering and construction company can be given work on a direct reimbursable basis to start with followed by conversion to LSTK once sufficient time and resources can be allocated to quantifying and pricing the scope of works. One method to convert from a reimbursable to LSTK Contract is called an Open Book Estimate or OBE in which the Contractor will open all their working documentation or books for representatives of the client to assess what the total scope of works for delivering the project will be. An agreed LSTK scope of works and price will be negotiated and agreed between EPC Contractor and Project Owner during the execution of EPC activities.

B. Concept of Knowledge Management

In Supply Chain Organizations employee retires, business value change and process are redefined. Though this is a natural part of the business environment, how do these affect the informational supply chain? While information supply chain is an intangible part of the supply chain, its presence is a major factor in adding value to the supply chain organizations. Without efficient knowledge management in place, information that is critical or ongoing or future success of supply chain may be jeopardized. Within this supply chain the type of information exchanged and its usage can be a deciding factor in how strategic an organization becomes in the market place. Unless information is accessed or shared and then used by supply managers, there is little chance that any competitive advantage will be realized.

C. MIS Approach

Science may be said to progress on its methods. The production of knowledge depends very much on the techniques for collecting, analyzing, and interpreting data and on the way they are applied. The same may be said of management information systems (MIS). The academic study of MIS relies very much on the methods used to answer research questions and test research hypotheses, and on the careful application of these methods. Moreover, since the methods are borrowed for the most part from established disciplines, the issue of appropriate and skillful application becomes Key. And this is especially the case in survey research where the basic methods have been known since the fifties, but where the application in many fields continues to fall short of the theoretical ideal.

This study explains the important factors that influence business success in EPC sector among various EPC industries located in India. Total five factors namely Front End Engineering, Business Process Reengineering (BPR), Vendor Selection, Order Management& Logistics Management are considered with 29 sub factors. The study consists of six sections. After this introduction, in Section II, review of the relevant literature is given. It helps in establishing a link between Supply Chain Management and implementation in EPC Sector. Section III contains research methodology. The result and comparative analysis of various factors of green supply chain management by calculating 'mean score' are presented in section IV. Section V contains validity confirmation through SEM. Finally, the conclusion is presented in section VI.

II. LITERATURE REVIEW

The works on the evaluation and/or Supply Chain Management are abundant; those that concern implementation of SCM in EPC Sector are rather limited. SCM is a concept that has originated and flourished in the manufacturing industry. The first signs of SCM were perceptible in the JIT delivery system as part of the Toyota Production System (Shingo 1988). This system aimed to regulate supplies to the Toyota motor factoryjust in the right - small - amount, just on the right time. The main goal was to decrease inventory drastically, and to regulate the suppliers' interaction with the production line more effectively. After its emergence in the Japanese automotive industry as part of a production system, the conceptual evolution of SCM has resulted in an autonomous status of the concept in industrial management theory, and a distinct subject of scientific research, as discussed in literature on SCM (e.g., Bechtel and Yayaram 1997, Cooper et al. 1997). Along with original SCM approaches, other management concepts (e.g., value chain, extended enterprise) have been influencing the conceptual evolution towards the present understanding of SCM.Supply chain management is extremely current due to its success in other industries and therefore considered to be the future of constructions EPC contracts by some academics. According to Constructing Excellence (2004), products and services provided by external businesses typically account for 80% of the total cost of projects, this means that main contractors have an ever-expanding supply chain as more packages are let to subcontractors rather than being done in-house. The Latham and Egan reports highlighted the requirement of outsourcing causing more emphasis on developing relationships within supply chains; as a result an explosion of research has gone in to SCM. However, as Briscoe and Dainty (2005, p.319) discussed, the EPC industry 'remains characterized by adversarial practices and disjointed supply relationships.

III. RESEARCH METHODOLOGY

The task of designing the questionnaire was carried out after reviewing a variety of literature on SCM &EPC (Eric Johnson) (NghiM. Nguyen), Based on the literature review, a tentative list of the factors was developed. The task of designing the questionnaire was carried out after reviewing a variety of literature. In the pre-testing phase of the questionnaire, practicing industry representatives were consulted for their view on the criteria selected and whether all the relevant criteria were covered in the questionnaire. Based on their feedback, the criteria list was modified and put into a structured form, with each sub-criteria falling under their respective criteria/major criteria. At the end of the pre - testing stage, 29 sub-criteria under the heading of five major criteria were finalized. Each criterion in the questionnaire was judged on a five point Likert Scale, where, 1 = very low, 2 = low, 3 = moderate, 4 = high and 5 = very high. Likert scale is a tried and tested scale has been successfully used in many cases, including supplier selection. Reliability indicates the extent to which an experiment, test or any other measuring procedure yields the same results [17]. The reliability assessment was conducted on Statistical Package for the Social Sciences (SPSS) software. The methodology adopted was similar to the one described by Pallant J. in her book on SPSS.

The responses were obtained from various verticals of EPC such as Oil & Gas, Power, Steel, Offshore, Infrastructures and Port Projects. Managers/ higher level authority in different level of organizations were interviewed. This was made to obtain accurate information and data to help in the formulation of the important green evaluation measures.

Pallant J. stated in her book that reliability can be measured in various ways. The most common method to measure reliability is by using Cronbach's alpha, which was carried out using SPSS. The value ranges from 0 to 1, with higher values indicating greater reliability. Nunnally (1978) recommended a minimum value of 0.7. Cronbach's alpha values are

dependent on the number of items on the scale. If the number of items in the scale is less than 10 (as in this study, where each criterion has 10 or less sub-criteria under it) then Cronbach's alpha values can be quite small. Here, the mean inter-item correlations were also calculated. J. Pallant [17] recommended their optimum value to be above 0.3. Item analysis was conducted for each of the 29 parameters through a mean score method. These dimensions are represented in the form of a questionnaire, for measuring the different facets of Important SCM factors used in EPC.

IV. FACTOR ANALYSIS

A. Reliability Analysis

Reliability indicates the extent to which an experiment, test or any other measuring procedure yields the same results. Reliability analysis was carried out using total 29 criteria on SPSS software. The final Cronbach's values and the range of correlation coefficient give an idea about the scale chosen. It also helps find that the sub-criteria have been properly assigned to their respective criteria or not. The final Cronbach's alpha values should be more than 0.7. Table 1 shows the reliability analysis of the major criteria selected for the study.

Table 1: Reliability Analysis

Criteria	Total Items	Final Cronbach's Alpha	Range of Correlation Coefficients
Front End Engineering	5	0.702	0.120-0.695
Business Process Reengineering	6	0.761	0.391-0.612
Vendor Selection	6	0.748	0.249-0.761
Order Management	7	0.728	0.155-0.627
Logistics Management	5	0.715	0.392-0.622

B. KMO and Bartlett's Test of Sphericity

The next appropriateness for factor analysis was determined by examining the strength of relationships among the sub-criteria. This was conducted by three measures, the coefficients in the correlation matrix, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. Tabachnick and Fidell recommended an inspection of the correlation matrix for evidence of coefficients greater than 0.3. The study stated that if only a few correlations above the required level are found, the factor analysis may not be appropriate.

The Bartlett's test of sphericity should be significant ($p < 0.05$) in the factor analysis to be considered appropriate. The KMO index ranges from 0 to 1 with 0.6 recommended as the minimum value [17]. Meanwhile Digalwar and Sangwan [18] recommended KMO value more than 0.5 as optimal. Final Cronbach's alpha value and range of correlation coefficients is calculated using reliability analysis. Also, the correlation matrix in Table 1 shows that a majority of the correlations are greater than 0.3. It can be seen from the table that reliability analysis confirms all the seven major criteria are suitable for applying factor analysis. This indicates that the sub-criteria have common factors [18].

Table 2 shows KMO and Bartlett's test of sphericity analysis of the major criteria selected for the study. Analysis of the KMO measure using SPSS in Table 2 reveals that all the measures meet the required standard. The Bartlett's test indicates that all the criteria are significant ($p < 0.05$).

C. Factor Analysis

Factor analysis was conducted on each criterion. The components were extracted in SPSS using principal component analysis with varimax rotation. Initially, factors with Eigen value over one were extracted and the scree plot along

with the unrotated factor solution analysed. Those factors with a significant slope above the bend in the scree plot were extracted [17]. A sample scree plot for green design criterion is shown in Figure 1 and sample component plot for green design is shown in Figure 2.

Table 2: KMO and Bartlett's Test of Sphericity

Criteria	KMO	Bartlett's Significance Value (p)
Front End Engineering	0.643	0.000
Business Process Reengineering	0.739	0.000
Vendor Selection	0.718	0.000
Order Management	0.609	0.000
Logistics Management	0.625	0.000

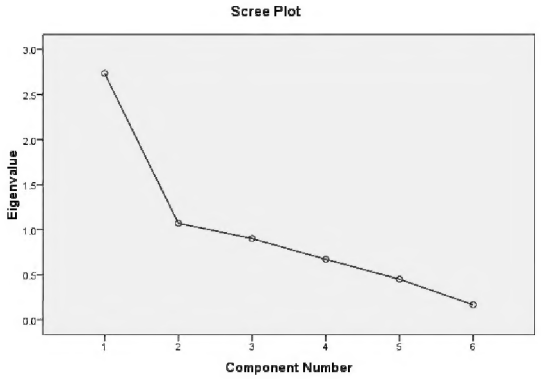

Figure 1: Sample Scree Plot for Vendor Selection

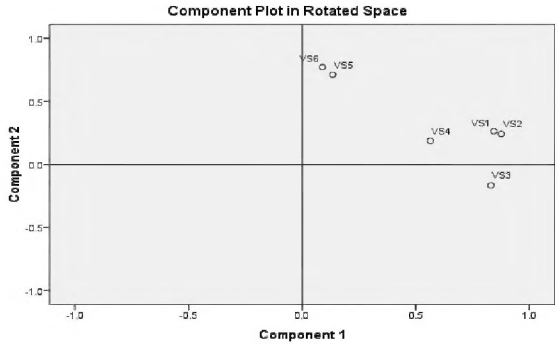

Figure 2: Sample Component Plot for Vendor Selection

Results of the factor analysis are shown in Table 3

Table 3: Factor Analysis

Criteria	Eigen Value	% Variance	Factors Extracted
Front End Engineering	2.563 1.222	51.269 75.710	2
Business Process Reengineering	3.099 1.131	51.648 70.496	2
Vendor Selection	2.735 1.072	45.589 63.451	2
Order Management	2.875 1.645	41.069 64.568	2
Logistics Management	2.508 1.125	50.157 72.661	2

Five supply chain factors with 29 underlying dimensions considered in this study and each dimension has its own importance for effective green supply chain performance. Table 4 to Table 11 shows the mean values (M) and standard deviation (S.D) of the criteria and sub-criteria respectively obtained from various respondents. The tables show the important criteria in the descending order of their means. Higher mean values indicate more important criteria.

Table 4: Performance of Main Factors

Criteria	Mean	Std. Deviation
Vendor Selection	4.31	0.69
Business Process Reengineering	4.03	0.72
Order Management	3.99	0.78
Logistics Management	3.98	0.43
Front End Engineering	3.88	0.82

Among all five main supply chain factors quality (4.31) was the most important criteria for the EPC industry in India. BPR was followed by Order Management, Logistics Management, and Front End Engineering respectively.

Table 5: Performance of Front End Engineering

Sub-Criteria	Mean	Std. Deviation
Realization based on Feasibility Studies	4.30	0.69
Planning and Scheduling	3.84	0.86
Site Identification and Evaluation	3.77	0.73
Technological Tie ups	3.76	0.95
Process Simulation/ Prototype Preparation	3.73	0.88

Front End Engineering which had 5 underlying dimensions was having Feasibility realization (4.30) as the most important dimension.

Table 6: Performance of Business Process Reengineering

Sub-Criteria	Mean	Std. Deviation
Bench Marking	4.34	0.56
ERP Implementation	4.29	0.59
Risk Management	4.24	0.62
Managerial Skill sets	4.14	0.75
Revising reward and motivation systems	3.67	0.86
Project related manpower recruitment	3.50	0.93

BPR which had6 underlying dimensions was having Bench Marking as most important factor (4.34) since BPR is responsible for business people relation.

Table 7: Performance of Vendor Selection

Sub-Criteria	Mean	Std. Deviation
Technical quality/ Co Design Capability	4.76	0.49
Delivery	4.44	0.69
Financial Background	4.26	0.79
Reputation	4.19	0.71
Role of vendor Order History	4.17	0.80
After sale service	4.06	0.66

Vendor Selection which had 6 underlying dimensions was having a quality (4.76) as the most important factors since quality plays vital role in vendor selection.

Table 8: Performance of Order Management

Sub-Criteria	Mean	Std. Deviation
Cost Consciousness	4.50	0.65
IT Implementation	4.41	0.63
MIS (Management Information System)	4.21	0.72
Payment Conditions	4.03	0.90
Low cost Country Sourcing	3.87	0.80
Make / Outsource decisions	3.46	0.91
Market Critical level	3.41	0.86

Order Management which had 7 underlying dimensions was having cost consciousness (4.50) as the most important dimension followed by IT implementation for the business success.

Table 9: Performance of Logistics Management

Sub-Criteria	Mean	Std. Deviation
LIS (Logistics Informatory System)	4.06	0.54
DRP (Distribution Requirement Planning)	4.03	0.38
Handling Analysis	3.97	0.24
Packaging Techniques	3.97	0.45
Warehousing Management	3.89	0.55

Logistics Management which had 5 underlying dimensions was having LIS Logistics Informatory system (4.06) as the most important factor.

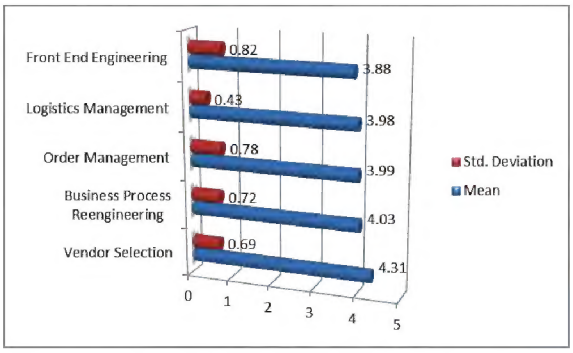

Figure 3: Importance of the Major SCM Criteria in Indian EPC Industries

V. STRUCTURAL EQUATION MODELLING

Structural Equation Modelling (SEM) has become one of the techniques of choice for researchers across disciplines and increasingly is a 'must' for researchers in the social sciences. However the issue of how the model that best represents the data reflects underlying theory, known as model fit is by no means agreed. With the abundance of fit indices available to the researcher and the wide disparity in agreement on not only which indices to report but also what the cut-offs for various indices actually are, it is possible that researchers can become overwhelmed by the conflicting information available. It is essential that researchers using the technique are comfortable with the area since assessing whether a specified model 'fits' the data is one of the most important steps in structural equation modelling (Yuan, 2005).

Most statistical methods only require one statistical test to determine the significance of the analyses. However, in CFA, several statistical tests are used to determine how well the model fits to the data. Note that a good fit between the model and the data does not mean that the model is "correct", or even that it explains a large proportion of the covariance. A "good model fit" only indicates that the model is plausible. When reporting the results of a confirmatory factor analysis,

one is urged to report: a) the proposed models, b) any modifications made, c) which measures identify each latent variable, d) correlations between latent variables, e) any other pertinent information, such as whether constraints are used. With regard to selecting model fit statistics to report, one should not simply report the statistics that estimate the best fit, though this may be tempting. Though several varying opinions exist, Kline (2010) recommends reporting the Chi-squared test i.e., the CMIN/DF, RMSEA, the CFI &RMR. Amos introduced a way of specifying models in terms of path diagrams. These path diagrams follow a set of standard conventions. It is an important skill to be able to convert theoretical hypotheses and the data into a path diagram

A. CMIN/DF

Table 10: CMIN/DF

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	45	114.236	108	.322	1.058
Saturated model	153	.000	0		
Independence model	17	360.658	136	.000	2.652

B. RMSEA

The RMSEA is the second fit statistic reported in the LISREL program and was first developed by Steiger and Lind (1980, cited in Steiger, 1990). The RMSEA tells us how well the model, with unknown but optimally chosen parameter estimates would fit the population's covariance matrix (Byrne, 1998). In recent years it has become regarded as 'one of the most informative fit indices' (Diamantopoulos and Siguaw, 2000: 85) due to its sensitivity to the number of estimated parameters in the model. In other words, the RMSEA favours parsimony in that it will choose the model with the lesser number of parameters. Recommendations for RMSEA cut-off points have been reduced considerably in the last fifteen years. Up until the early nineties, an RMSEA in the range of 0.05 to 0.10 was considered an indication of fair fit and values above 0.10 indicated poor fit (MacCallum et al, 1996). It was then thought that an RMSEA of between**0.08 to 0.10** provides a mediocre fit and below 0.08 shows a good fit (MacCallum et al, 1996). However, more recently, a cut-off value close to .06 (Hu and Bentler, 1999) or a stringent upper limit of 0.07 (Steiger, 2007) seems to be the general consensus amongst authorities in this area. One of the greatest advantages of the RMSEA is its ability for a confidence interval to be calculated around its value (MacCallum et al, 1996). This is possible due to the known distribution values of the statistic and subsequently allows for the null hypothesis (poor fit) to be tested more precisely (McQuitty, 2004). It is generally reported in conjunction with the RMSEA and in a well-fitting model the lower limit is close to 0 while the upper limit should be less than 0.08.

Table 11: RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.029	.000	.070	.760
Independence model	.155	.135	.174	.000

C. RMR

The RMR and the SRMR are the square root of the difference between the residuals of the sample covariance matrix and the hypothesised covariance model. The range of the RMR is calculated based upon the scales of each indicator, therefore, if a questionnaire contains items with varying levels (some items may range from 1 – 5 while others range from 1 – 7) the RMR becomes difficult to interpret (Kline, 2005). The standardised RMR (SRMR) resolves this problem and

is therefore much more meaningful to interpret. Values for the SRMR range from zero to 1.0 with well fitting models obtaining values less than .05 (Byrne, 1998 Diamantopoulos and Siguaw, 2000), however values as high as 0.08 are deemed acceptable (Hu andBentler, 1999). An SRMR of 0 indicates perfect fit but it must be noted that SRMR will be lower when there isa high number of parameters in the model and in models based on large sample sizes.

Table 12: RMR

Model	RMR	GFI	AGFI	PGFI
Default model	.047	.901	.850	.600
Saturated model	.000	1.000		
Independence model	.115	.624	.577	.555

D. CFI

The Comparative Fit Index (CFI: Bentler, 1990) is a revised form of the NFI which takes into account sample size (Byrne, 1998) that performs well even when sample size is small (Tabachnick and Fidell, 2007). This index was first introduced by Bentler (1990) and subsequently included as part of the fit indices in his EQS program (Kline, 2005). Like the NFI, this statistic assumes that all latent variables are uncorrelated (null/independence model) and compares the sample covariance matrix with this null model. As with the NFI, values for this statistic range between 0.0 and 1.0 with values closer to 1.0 indicating good fit. A cut-off criterion of CFI $\geq$ 0.90 was initially advanced however, recent studies have shown that a value greater than0.90 is needed in order to ensure that misspecified models are not accepted (Hu and Bentler, 1999). From this, a value of CFI $\geq$ 0.95 is presently recognised as indicative of good fit (Hu and Bentler, 1999). Today this index is included in all SEM programs and is one of the most popularly reported fit indices due to being one of the measures least affected by sample size (Fan et al, 1999).

Table 13: CFI

Model	NFI Delta1	RFI Rho1	IFI Delta2	TLI Rho2	CFI
Default model	.683	.601	.975	.965	.972
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

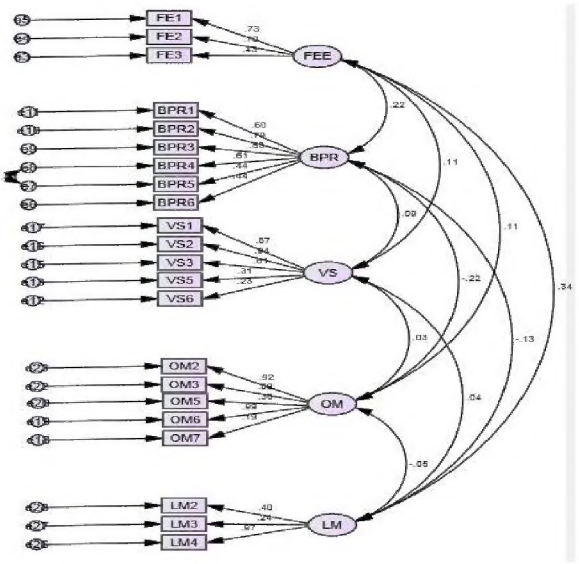

Figure 4: Graphical Representation of Model Developed for SCM Factors through AMOS V.21

VI. CONCLUSIONS

The research presents practitioners with a 1 to 5 item measurement scale for evaluating the different facets of their Supply Chain Factors in EPC sector importance of Supply chain in EPC industry is very much important like other industries. The present empirical study investigated the SCM practices adopted by different industries like L&T, Technip, Relaince, Leighton etc. The study investigated the important factor that influences business success in the EPC sector through "mean method" through factor analysis. MIS methodology helped to collect, validate the data obtained from the surveys.

The analysis result indicates that Vendor Selection is the most important SCM factor that is responsible for successful business in EPC Sector, since Vendor Selection determines the quality, cost and timely delivery of the EPC project. Business Process Reengineering stands second since BPR is the factor which aligns people, processes and technology with strategies in order to achieve business integration and success. Order Management which analyses the market sentiments, trends, commercial variations stay third important to the success. Logistics Management factor stands moderate since cost factor mainly depends upon the location of the vendor from where the material is to be procured and hence it is very important to consider this factor while estimating the project cost. Also in case of Logistics management the Information System plays a vital role as integration of logistics to e-business is the future trend. Front End Engineering was surprisingly at the least important criteria which means that the client or end user takes the risk of Engineering, designing and validation of the equipment/ layout of the Project and hence it is not preferred. It was also observed by the interviews that most of the client in Public and Private Sectors for ex: NTPC, ONGC, JSW, Tata power have consultants for validating the design so the responsibility mostly shifted to the consultants than the EPC Contractor.

Further Confirmatory Factor Analysis help to determine what the factor looks like how the participant responded. In this study it was found that the model proposed through respondents input is perfectly fit to the indices given (Kline, 2010).Normally it is asserted that CFA model can only be taken as plausible model. As a final point it must be noted that while fit indices are a useful guide, a structural model should also be examined with respect to substantive theory. By allowing model fit to drive the research process it moves away from the original, theory-testing purpose of structural equation modelling. In addition, fit indices may point to a well-fitting model when in actual fact, parts of the model may fit poorly (Jöreskog and Sörbom, 1996; Tomarken and Waller, 2003; Reisinger and Mavondo, 2006). Indeed, the area of fit indices 'rules of thumb' is highly topical at the moment with some experts in the area calling for a complete abandonment off it indices altogether (Barrett, 2007). Others are less hesitant to denounce their usefulness but do agree that strictly adhering to recommended cut-off values can lead to instances of Type I error (the incorrect rejection of an acceptable model) (Marsh et al, 2004). Although the debate is ongoing, it is unlikely in this case the model confirms that out of 29 latent factors 21 factors confirm fitness to the standard indices in addition to factor analysis.

REFERENCES

1. Chopra S., Meindl P. (2001), Supply Chain Management – Strategy, Planning, and Operation, Vol. 3.
2. L. Levine, "Integrating Knowledge and Processes in a Learning Organization". Information Systems Management Vol.18, No.1, 2001, pp.21-23.
3. Anderson, David L., Britt. Frank E, and Favre. Donavon J., The seven principle of Supply Chain Management, Logistics Management.

4. Cattell, R. B. (1966). The scree test for the number of factors. Multivariate Behavioral Research, 1, 245-276.
5. Child, D. (1990). The essentials of factor analysis, second edition. London: Cassel Educational Limited.
6. DeVellis, R. F. (1991). Scale Development: Theory and Applications. Newbury Park, California: Sage Publications.
7. Dunn, L. M. & Markwardt, J. C. (1970). Peabody individual achievement test manual. Circle Pines, MN: American Guidance Service.
8. Hahn, M. E. (1966). California Life Goals Evaluation Schedule. Palo Alto, CA: Western Psychological Services.
9. Hu, L., & Bentler, P. M. (1995). Evaluation model fit. In R. H. Hoyle
10. (Eds), Structural equation modeling: Concepts, issues, and applications (pp.76–99). Thousand Oaks, CA: Sage.
11. Hu, L.-T., & Bentler, P. M. (1999). Cut off criteria for fit indices in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling, 6, 1–55.
12. Kaplan, D. (2000). Structural equation modeling: Foundations and extensions. Thousand Oaks, CA: Sage.
13. Kline, R. B. (2005). Principles *and practices of structural equation modeling*2005, pp. 627–632.
14. Hammed S. (2007), How Should We Define SCM
15. Anderson, David L., Britt. Frank E., and Favre. Donavon J., The seven principle of Supply Chain Management, Logistics Management
16. J. Sarkis, "A strategic decision framework for supply chain management", *Journal of Cleaner Production*, Vol.11, 2003, pp. 397–409.
17. Bearnon, B.M (1998), "Supply Chain design & analysis: Models & Methods," International Journal of Production Economics, Vol. 55 pp. 281-294
18. J. Pallant, *SPSS Survival manual*, Open University press, 2001.
19. A. K. Digalwar, K. S. Sangwan, "Development and validation of performance measures for world class manufacturing practices in India", *Journal of Advanced Manufacturing Systems*, vol.6, 2007, pp. 21–38.

AUTHOR'S DETAILS

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